Model Improvement & Study Management Agency

Deputy Under Secretary of the Army (Operations Research)

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APRIL 1995

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20 March 1995

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MEMORANDUM FOR SEE DISTRIBUTION LIST

SUBJECT: Army Study Highlights, Volume XV

The Army Study Highlights is published annually to acknowledge outstanding efforts of individual and group analysts and to encourage continued excellence in the Army analysis community. The visibility provided by this publication is an opportunity for others to take advantage of examples of good work. A panel of experienced senior level analysts selected eleven studies for this volume. Those studies were quite varied which provided an interesting mix.

The studies selected represent examples of efforts that were professionally conducted and are of significance to the Army's missions and goals. Selections were based on an assessment of the principal findings, main assumptions, principal limitations, scope, objectives and approach of each study. Examples of quality analysis have proven to be beneficial to the younger analysts entering the analysis community as well as a refresher for the more experienced analysts. I urge you to make the widest possible distribution of this publication.

This volume also serves to recognize recipients of the 1994 Dr. Wilbur B . Payne Memorial Award for Excellence in Analysis. Two awards were presented this past year, one for the best individual authored paper and one for the best group authored paper. Each year these awards are presented at the Army Operations Research Symposium, Fort Lee, VA. We are proud to include excerpts of this outstanding work in the Army Study Highlights.

We welcome your suggestions. Comments and requests for additional copies of this publication should be directed to Ms. Gloria Brown, of this agency, (DSN) 327-3417 / (C) 703/607-3417.

JOANN H. LANGSTON, Director
Model Improvement and Study
Management Agency
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CONTENTS

STUDY GISTS

Abstracts from the Dr. Wilbur B. Payne
Memorial Award for Excellence in Analysis
1994 Papers

DEFENSE AGAINST WEAPONS OF MASS DESTRUCTION

Study Gist

PRINCIPAL FINDINGS

(1) The threat posed by possible North Korean use of TBMs carrying WMD was real and our ability to defend against these current and projected threats was limited.

(2) Current active defense systems are not leakproof and are limited by deployed quantities.

(3) Current attack operations are limited by sensor-shooter times and by projected North Korean use of underground facilities.

(4) Current C4I is the major limiting factor to the effectiveness of all other pillars, the lack of automated data fusion and dissemination is a major shortcoming. Future systems will do much to correct some of these problems.

(5) Active defense will improve and will continue to offer the most effective, high confidence protection against TBMs.

(6) Attack operations capabilities will improve, but will continue to be an inefficient use of resources unless North Korean use of underground facilities is interdicted.

(7) C4I will continue to hamstring the other pillars, despite fielding of new equipment because the equipment is being fielded in only limited quantities.

MAIN ASSUMPTIONS

(1) The scenarios used in this study are representative of likely situations involving TMD.

(2) US and North Korean force structures and equipment used in the scenarios will perform according to their specifications.

(3) Current fielding dates for US systems will not change.

(4) Projected Army force structures for the time frame (FY2005) are correct.

PRINCIPAL LIMITATION

The study leveraged ongoing or completed work due to the short timelines.

SCOPE OF THE STUDY

(1) This study considered three of the four pillars of TMD: active defense, attack operations, and C4I.

(2) The US Army Chemical School conducted a separate analysis of the passive defense pillar.

(3) The study examined current (FY95) and future (FY05) North Korean TBM/WMD threat and the capabilities of USFK to defeat the threat.

STUDY OBJECTIVES

(1) During the period February 1994 to September 1994, D&SA Battle Lab in conjunction with the joint Precision Strike Demonstration and the CINCUSFK conducted a WMD TMD study using a variety of tools to include simulations, live fires demonstrations and analysis. The intent of the study was to review current procedures and capabilities, providing recommendations

to CINCUSFK on alternative DOTLMS solutions; investigate the affects of emerging and advanced technology, identifying potential high payoff DOTLMS solutions from which Joint Precision Strike Demonstration and D&SA Battle Lab can conduct further analysis during excursions planned in support of the FY 95 Precision Strike.

(2) No single solution set will provide the degree of assurance that the US Army and sister service capabilities either now or in the future will be able to defeat a WMD threat. CINCUSFK must have a robust architecture that links joint and combined assets together to destroy this threat. Consequently, this study included an assessment of current and emerging joint capabilities, with the intent of assessing how best to integrate service assets in the Korean theater.

(3) TRAC served as the lead analytical agency to pull together existing documentation relating to WMD and TMD solutions. This included a complete assessment of current and future capabilities of USFK against North Korean WMD.

THE BASIC APPROACH

(1) The approach was one of three parallel efforts: establishing the threat and TMD mission, identifying current TMD capabilities and shortcomings of each service, and identifying future TMD capabilities of each service. To do this the study relied primarily on results of previous TMD related studies, the majority of which addressed Korea as a vignette within a larger scenario suite.

(2) New work was also done with TRAC-SAC using FE (Force Effectiveness) to model active defense capabilities and TRAC-WSMR using the Attack Operations Model to model attack operations capabilities.

THE REASON FOR PERFORMING THE STUDY

The Defense Against Weapons of Mass Destruction Study supports an Army assessment of the Louisiana Maneuver 1994 issue, Weapons of Mass Destruction. The study focuses on the adequacy of current and projected capabilities of US. Forces Korea (USFK) Theater Missile Defense (TMD) against current and projected North Korean WMD.

STUDY IMPACT

The Defense Against Weapons of Mass Destruction Study provided the analytic basis in response to current and projected capabilities of the USFK Theater Missile Defense against current and projected North Korean WMD.

THE STUDY SPONSOR AND PROPONENT: Director, Depth and Simultaneous Attack Battle Lab, Fort Sill, OK 73503.

PERFORMING ORGANIZATION AND PRINCIPLE AUTHORS

TRADOC Analysis Center, Study and Analysis Center
ATTN: ATRC-SAA
Fort Leavenworth, Kansas 66027-2345
Principal Authors: LTC Morris L. Paulsen and CPT(P) Edwin H. Harris III

DTIC ACCESSION NUMBER: Unknown.

COMMENTS AND QUESTIONS MAY BE SENT TO: Performing Organization, DSN 552-5426/5427, Commercial (913) 684-5426/5427.

START AND COMPLETION DATES OF THE STUDY: FEB-SEP 94

	Early Entry Force Analysis	**STUDY GIST**

PRINCIPAL FINDINGS

1. Organizational

a. In the lightweight analysis, the third adjustment maximized the organization's lethality and survivability while minimizing deployment and sustainment requirements.

b. In the middleweight analysis, the base case (derived from the 10K Analysis Study) achieved nearly 100 percent of the goal for the two top priority warfighting characteristics of deployability and survivability.

2. Deployability

a. The expected percentage of total daily lift allocated to the Army will not be enough to meet the deployment goals.

b. The lightweight force requires an excess of two-thirds of the total daily lift.

c. The middleweight force requires only slightly more than the Army's expected share.

d. A ten percent increase in daily lift will result in three to five days less deployment time.

3. Lethality

a. Advanced technology systems increase lethality while decreasing sustainment.

b. The lightweight force was reduced in half without major changes in lethality, survivability, or combat service support.

c. Opposed entry mission success can be assured with careful tailoring of units and unit sequencing.

MAIN ASSUMPTIONS

1. System definitions would be available in sufficient detail for evaluation purposes.

2. Threat doctrine, equipment, and force structure projections through 2006 were accurate.

3. Blue doctrine and equipment projections were accurate.

4. Host nation doctrine, equipment, and force structure projection through 2001 were accurate.

5. Approved surrogate data would be available for identified data deficiencies.

6. Supply requirements based on Army planning factors were representative of actual supply consumption.

7. Army lightweight or middleweight forces are the only force available for this scenario.

PRINCIPAL LIMITATIONS

1. Seaport operations are not addressed.

2. Joint requirements are not addressed.

SCOPE OF THE STUDY

1. The European Command (EUCOM) 11 Scenario was developed for this analysis and study-certified by the U.S. Army's Training and Doctrine Command Analysis Center (TRAC) Scenario and Wargaming Center (SWC). EUCOM 11 contains an early entry mission: however, because of the configuration of the terrain, and the success of the deep fight systems, there is not enough of a close fight to properly assess close-range and extended closer-range systems.

2. The 10K Prime Force recommended in the 10K Force Analysis Study was used as the basis for the Army middleweight force. This force was patterned on an existing division(-) force package with the addition of new technology such as Longbow, LOSAT, NLOS, and smart munitions.

3. Blue force structures are primarily 2001, but include some non-POM equipment.

4. Threat force year is 2006.

5. Conventional and unconventional units and weapons were addressed in the study. Unconventional weapons were limited to chemical munitions.

6. Since the emphasis in the National Military Strategy is on decisive victory with minimum casualties, the study provided estimates of personnel casualties.

STUDY OBJECTIVES

1. To determine how to make light forces more lethal, survivable, tactically mobile, and sustainable.

2. To determine the potential contribution to the battlefield by middleweight units, light enough for rapid force projection, yet more tactically mobile, lethal, and sustainable than current light forces.

BASIC APPROACH

1. Initial Input. Leveraged results from the 2K and 10K studies and guidance for the LAM '94 issue *More Lethal, Survivable, Deployable Forces* to develop a base case force package for the Army lightweight and Army middleweight forces.

2. Force Sufficiency Analysis. An iterative process fought in an unopposed environment in which forces were adjusted until no additional improvement in the force could be obtained. Success was based on the attainment of goals for force sufficiency criteria, and the comparison of force performance against these goals determined whether additional improvement could be obtained.

3. Sensitivity Analysis. Used the lightweight objective package to conduct additional combat excursions to analyze the objective force package's capability to perform opposed entry missions.

4. Force Tailoring Analysis. Several tools were developed to assist in tailoring a force for any early entry scenario.

REASONS FOR PERFORMING THE STUDY

1. The Early Entry Force Analysis Study was conducted to address two sub-issues from the LAM '94 issue *More Lethal, Survivable, Deployable Forces*.

2. Existing early entry forces lack the lethality, survivability, deployability, sustainability, and tactical mobility to meet future force projection needs.

3. This study examined lightweight forces capable of being more lethal, survivable, sustainable, and tactically mobile, and middleweight forces which are capable of being deployed quickly with minimum decrement to the tactical mobility or lethality of heavier forces.

STUDY IMPACT

1. This study will be a building block for designing the forces for Force XXI.

2. Tools used in this study will provide CINCs and staffs fast and efficient means of organizing for combat.

3. Resultant middleweight force will serve as Mobile Strike Force '95 during Prairie Warrior '95.

STUDY SPONSORS

The Early Entry Lethality and Survivability Battle Lab, USA, HQ TRADOC, ATTN: ATCD-L, Ft. Monroe, VA 23651-5000.

PERFORMING ORGANIZATION AND PRINCIPAL AUTHORS

1. TRADOC Analysis Center (SAC), Study Directorate, Ft. Leavenworth, KS 66027-5200.

2. LTC(P) Thomas J. Pawlowski III
   MAJ David Rodgers
   CPT Thomas Cioppa
   Ms Carol Mullen

DTIC ACCESSION NUMBER

1. DTIC number pending.

2. Technical Report TRAC-TR-1494

COMMENTS AND QUESTIONS

1. TRADOC Analysis Center
   Study and Analysis Center
   Study Directorate
   Ft. Leavenworth, KS 66027-5200
   POC is CPT Thomas Cioppa at DSN 552-9209, or CIV (913)684-9209

2. Early Entry Lethality and Survivability Battle Lab
   USA, HQ TRADOC
   ATTN: ATCD-L
   Ft. Monroe, VA 23651-5000
   POC is LTC John Langhauser at DSN 680-5860 or CIV (804) 728-5860

START AND COMPLETION DATE

1. Start date: SEP 93
2. Completion Date: 15 SEP 94

EARLY ENTRY FORCE DEPLOYABILITY ANALYSIS

THE PRINCIPAL FINDINGS

(1) In terms of airlift requirements, an early entry "lightweight" force or tailored light infantry division with the addition of the MLRS and AGS weapon systems could be airlifted in 1,264 C-141 and 37 C-5 planeloads and close at a European Command (EUCOM) air port of debarkation (APOD) by C+26. Adjustments made to the force by the Early Entry Lethality and Survivability (EELS) Battle Lab to improve deployability included removing two infantry brigades and the AGS battalion, replacing the OH-58D with AH-66 helicopters and the Hawk with Corps SAM, and adding a LOSAT company. These changes resulted in a reduction of the C-141 requirement by 30-40% (to 776 planeloads) and allowed the force to arrive at the APOD by C+18.

(2) An early entry "middleweight" force which includes a light infantry brigade, Comanche recon battalion, HIMARS battery, and Corps SAM battery required 1,017 C-141 and 87 C-5 planeloads to deploy and arrived at the EUCOM APOD on C+25. In addition, a balanced mechanized infantry brigade prepositioned afloat was included in the force.

(3) Given a joint deployment, the average Army share of the airlift over the first 30 days was 47%. An increase to a 57% share would on average decrease the deployment time of the lightweight force by 3.5 days and the middleweight force by 4.5 days.

THE MAIN ASSUMPTIONS

(1) The early entry force analyzed would be the Commander in Chief's, Supreme Allied Commander, Europe first priority for deployment and would begin arriving in Europe on C+1.

(2) The EUCOM joint time-phased force deployment list (TPFDL) used in the analysis is representative of an early entry operation.

THE PRINCIPAL LIMITATION is that the study includes deployment of small arms ammunition only and does not consider deployment requirements for the large tonnage of ammunition needed for weapon systems.

THE SCOPE OF THE STUDY

(1) The deployment includes movement of the forces from CONUS origins through air ports of embarkation (APOEs) to EUCOM South APODs.

(2) A combination of current and future (2001) weapon systems and strategic airlift assets are considered.

THE STUDY OBJECTIVES

(1) The analysis examines the deployability, in terms of lift assets and total time required to deploy both a "lightweight" and "middleweight" early entry force, as designed by the EELS Battle Lab, as well as adjustments to each.

(2) The analysis shows how fast the forces' combat power can be delivered to EUCOM South within a joint deployment and to compare the impact of future weapon systems on the deployability of the force.

THE BASIC APPROACH

(1) Unit deployment movement data and C-5 and C-141 planeload requirements were generated for both the "lightweight" and "middleweight" forces using MTMCTEA's Transportability Analysis Reports Generator (TARGET).

(2) AMC's MASS model was used to predict the average daily Army share for the first 30 days of airlift into destination APODs.

(3) This average daily share was used to determine the day-by-day closure profiles of each force analyzed. Additional closure profiles were derived using plus and minus ten percent of this share.

THE REASONS FOR PERFORMING THE STUDY

(1) The Army must possess the capability to rapidly deploy and insert "first to fight" forces.

(2) The future Army must be able to conduct early entry operations with tailored armored, light, and special operations forces that are more lethal, survivable, and deployable.

THE STUDY IMPACT will be to provide TRADOC decision makers force design alternatives in terms of quantified deployment data, specifically, required airlift assets and closure times.

THE STUDY SPONSOR is the TRADOC Early Entry Lethality and Survivability Battle Lab, Fort Monroe, Virginia.

THE PRINCIPAL AUTHORS AND PERFORMING ORGANIZATIONS are Diane L. Buescher and CPT Rebecca W. Jones, USA of the Military Traffic Management Command Transportation Engineering Agency and Capt Lance J. Lindsley, USAF and Alan W. Whisman of the Air Mobility Command Studies and Analysis Flight.

COMMENTS AND QUESTIONS may be sent to Director, MTMCTEA, ATTN: MTTE-DPA, 720 Thimble Shoals Blvd. - Suite 130, Newport News, Virginia 23606-2574. POCs are Diane L. Buescher, DSN 927-5268, commercial 804-878-5268 and CPT Rebecca W. Jones, USA, DSN 927-5269, commercial 804-878-5269.

THE START DATE of the study was December 1993 and the completion date was September 1994.

AMSAA

STUDY GIST: Evaluation of Statistical Demand Forecasting

PRINCIPAL FINDING:

1) Adopting the SDF forecast method will mean a *significant change* in the process used by the Army to forecast wholesale level demand.
2) Using the original SDF logic which was proposed by the Navy would *not reduce Army wholesale operating costs*.
3) However, if the SDF logic enhancements described in this report are implemented, then SDF should result in *reduced wholesale holding and administrative procurement costs* for Army managed items.

SCOPE OF THE STUDY AND PRINCIPAL LIMITATIONS:

1) It would not have been practical to evaluate SDF in the field, and therefore SDF was *evaluated using a computer simulation model* of the Army wholesale inventory system.
2) This study does not cover PC SDF, and addresses *only the two demand forecasting subsystems of PD80;* computing Filters and Trends, and computing Demand Quantity Forecasts.
3) The SDF subsystems which were simulated had to be *duplicated in FORTRAN by AMSAA* rather than using the existing Navy COBOL code.

STUDY OBJECTIVES:

1) The first objective of this study was to *evaluate the effect on the Army's wholesale inventory system* of adopting the SDF methodology.
2) SDF was developed to reduce wholesale operating cost by improving forecast accuracy and reducing inventory level stability. The second objective of this study was to *identify the SDF logic enhancements* which would be required in order to achieve these same benefits when forecasting wholesale level demand for Supply Class IX items managed by the Army.

BASIC APPROACH:

1) This study was conducted in two stages. During the *first stage* the SDF methodology originally proposed by the Navy as a JLSC Standard System was compared to the Army's current forecasting method. Then, based on these results, the *second stage* involved identifying enhancements to the SDF logic which would improve SDF's performance when used to forecast demand for Army managed items. In each stage the Army's current method of forecasting wholesale level demand was used as the base line for evaluating the relative benefits of all other forecasting alternatives.
2) The primary *measures of performance* considered in this study were supply performance and wholesale operating cost. However, a number of other measures such as forecast accuracy, dollar value of assets above the requisition objective, and procurement order terminations were also considered.

3) These measures of performance were generated using a *simulation model* of the Army's wholesale inventory system, and *historical demand data* for Army managed items.
4) Based on output from this simulation a number of *SDF enhancements* were identified which improved SDF's performance for the Army managed items which were simulated.

REASONS FOR PERFORMING THE STUDY:

1) SDF is a demand forecasting methodology which was developed by the Navy. This methodology was selected by JLSC as the Standard System to be *used by all Services* for forecasting wholesale level demand for secondary items.
2) Adopting the SDF forecast methodology will mean a *significant change in the process* currently used by the Army to forecast wholesale level demand. The Army will be able to continue using the moving average forecast technique, but SDF will decide when to reforecast, how to address outlier demand observations, and whether a trend exists in the demand data.
3) These changes in the way demand forecasts are generated could have a *significant effect on inventory levels, supply performance, and the cost of doing business*. Therefore this study was conducted to evaluate, and then maximize, the beneficial effects associated with using SDF.

STUDY IMPACT:

Based on the analysis conducted during this study it was possible to develop, and justify the implementation of, SDF logic enhancements which will improve its ability to forecast wholesale level demand for Army managed items. These logic enhancements were found to *reduce* wholesale holding and administrative procurement costs by seven percent for the Armament, Munitions, and Chemical Command (AMCCOM) items simulated, and by two percent for the Aviation and Troop Command (ATCOM) items simulated. Without these logic enhancements the SDF logic resulted in holding and administrative procurement cost *increases* of two percent and seven percent for AMCCOM and ATCOM respectively.

STUDY SPONSOR:

The Joint Logistics Systems Center (JLSC)
1864 Fourth Street, Bldg 15, Suite 1
Wright-Patterson AFB, OH 45433-7131

PERFORMING ORGANIZATION/PRINCIPAL AUTHOR; COMMENTS AND QUESTIONS:

U.S. Army Materiel Systems Analysis Activity (AMSAA)
Attn: AMXSY-LM (Eric Wehde; DSN: 298-7847; ewehde@arl.mil)
Aberdeen Proving Ground, Maryland 21005

START AND COMPLETION DATE OF STUDY:

June 1992 to June 1994

PARAMETRIC ENDO/EXOATMOSPHERIC LETHALITY SIMULATION (PEELS)

STUDY GIST

REASONS FOR PERFORMING THE STUDY

Early FY 92 efforts to evaluate the lethality of Anti-Tactical Ballistic Missiles (ATBM) revealed the need to have an independent, fast-running tool to evaluate the lethal effectiveness of Hit-To-Kill (HTK) and fragmenting warhead interceptors against TBMs carrying submunition payloads. Previously existing tools were adequate to predict kills of certain unitary payloads on Tactical Ballistic Missiles (TBM) but were shown to be inadequate to realistically predict fractional kills of submunition payloads. Also, most previously existing tools were closely tied to specific interceptor designs.

STUDY OBJECTIVES

(1) Develop a capability to realistically evaluate kinetic energy kills of TBM targets carrying chemical and biological submunition payloads.

(2) Develop a fast-running code suitable for use in system acquisition decisions as well as predict trends in lethality using parametric techniques.

(3) Develop an independent evaluation tool to be used in evaluation of any Theater Missile Defense (TMD) interceptor system.

(4) Develop a tool that closely reproduces lethality test results.

STUDY IMPACT

(1) The capability provided by the PEELS model to assess the effectiveness of TMD interceptors based on hundreds of thousands of endgame engagements had a significant and substantial impact on the choice of a HTK interceptor for the PATRIOT PAC-3 system upgrades.

(2) Because of the unique capability PEELS provides, it now has a distribution of approximately 60 contractor and government agencies.

(3) PEELS is now being used internationally in feasibility studies of foreign Ballistic Missile Defense (BMD) systems.

BASIC APPROACH

(1) Combinatorial geometry modeling techniques are used to describe the physical characteristics of the target (geometry, layer thicknesses, and materials). Ray trace algorithms combined with the combinatorial geometry models are used to describe the characteristics of the target along a shotline (layer id, thickness, material, angle, etc.). This information is combined with shotline penetration and cratering algorithms , which are correlated to test data, to predict fragment lethality.

(2) Hit-To-Kill (HTK) scoring of submunition payloads is accomplished by describing the physics of the problem as an analogy to rod penetration and cratering. In this model, a Tate analogy is used to describe the physical dimensions of a crater, assuming the target and interceptor both exhibit a homogeneous continuum of material density and strength. The maximum theoretical crater dimensions are then constrained due to the geometric limits of the target and the impact configuration. Submunitions are scored as dead if the solid geometry which defines their physical dimensions are overlapped by the crater.

(3) The fragment and HTK models are integrated into two optional run modes. The first, database mode, utilizes a preprocessed database of shotline vector intersections and lethality predictions created using the fragment and HTK algorithms discussed above. Database mode is fast and efficient, but limited to those targets and fragment types used in creating the database. The second run mode, direct, uses the same fragment and HTK algorithms to perform direct in-line lethality calculations. Direct mode is more generalized since the calculations are performed in-line, but is consequently more computationally intensive.

THE PRINCIPAL FINDINGS

(1) The analytical code developed under this effort provides the first realistic means of evaluating partial payload kills of TBM targets carrying chemical or biological submunition payloads. Although PEELS also evaluates other payload types including nuclear and high explosive (submunition and unitary), the inclusion of chemical and biological submunition targets and the assessment of fractional payload kills represent significant advances in lethality assessment capability.

(2) The capability to evaluate fractional kills of TBMs with submunition payloads is required to realistically evaluate the effectiveness of ATBM systems currently under development. Current and future ATBMs must be evaluated for the protection they can provide for troops in the theater and for population centers.

(3) PEELS predictions of actual lethality tests (approximately 80 tests for HTK and 600 for fragments) shows an average absolute relative error of less than 11 percent.

(4) PEELS was accredited for lethality analysis in the PATRIOT PAC-3 Milestone II Acquisition decision. It is currently being reviewed for accreditation to support the THAAD Milestone II Acquisition decision

THE MAIN ASSUMPTIONS

(1) The target drawings utilized for the PEELS threat models are received from the Intelligence community and are assumed to represent viable threats for an ATBM system.

(2) Kill mechanisms are based upon the coupling of energy and momentum transfer between the penetrator and the target in the hydrodynamic phase of penetration.

(3) Kills of submunitions are dependent on satisfaction of kill criteria established for the TMD Program.

THE PRINCIPAL LIMITATIONS

(1) Target models are limited to the class of tactical ballistic missiles. Payload types addressed are unitary chemical and high explosive, nuclear, and chemical and biological submunitions. Currently, air-breather type targets are not included in the database.

(2) Interceptor model designs can range in mass from approximately 30 to 400 kg. However, ninety-five percent of the data is in the range from approximately 40 to 80 kg. Distribution of mass is critical to model performance. Density variations between interceptor sections may be as high as a factor of 3. Significant variations from currently included interceptor models may require code modifications and subsequent verification.

(3) Warhead fragment types are currently limited to steel and tungsten alloys with masses ranging from 10 to 200 grams and impact speed from 1 to 6 km/s.

THE SCOPE OF THE STUDY

(1) Develop a generalized computer model to allow the quantification of lethal effectiveness between a HTK missile and a fragmenting warhead missile against a host of threatening targets.

STUDY SPONSOR

Ballistic Missile Defense Organization (BMDO), Test and Evaluation Directorate, Washington, DC. Program Manager, Mr. Dan Whitener.

PERFORMING ORGANIZATION AND PRINCIPAL AUTHOR(S)

(1) Model developed completed by Mr. Jeffery Elder, Kaman Sciences Corporation, Huntsville, AL.

(2) Work accomplished under contract to the U.S. Army Space and Strategic Defense Command (USASSDC), Weapons Directorate, Lethality Division (formerly SLKT), Chief, Dr. Robert S. Becker, Task Manager, Ms. Angela Duran.

DTIC ACCESSION NUMBER OF FINAL REPORT
Not applicable

COMMENTS AND QUESTIONS MAY BE SENT TO:
Deputy Commander
U.S. Army Space and Strategic Defense Command
Attn: CSSD-WD-L (Ms. Angela Duran)
P.O. Box 1500
Huntsville, AL 35807-3801
DSN: 645-1607

START AND COMPLETION DATE OF STUDY

May 1992 through October 1994.

CAA — Concepts Analysis Agency, United States Army	**POLLUTION ABATEMENT AND PREVENTION ANALYSIS (PAPA) STUDY**	**STUDY SUMMARY CAA-SR-94-6**

THE REASON FOR PERFORMING THE STUDY was to develop and demonstrate an analytical methodology for evaluating the costs and benefits of investing in pollution abatement and prevention opportunities (PPOs) supporting US Army activities and facilities.

THE STUDY SPONSOR was the Assistant Secretary of the Army for Installations, Logistics, and Environment (ASAIL&E).

THE STUDY OBJECTIVES were to:

(1) Identify and evaluate pollution abatement opportunities.

(2) Identify and evaluate pollution prevention opportunities.

(3) Develop an analytical capability to generate and evaluate pollution abatement and prevention investment strategies supporting US Army activities and facilities.

(4) Develop and analyze pollution abatement and prevention investment strategies at selected continental United States (CONUS) Army facilities.

THE SCOPE OF THE STUDY

(1) Timeframe for analysis is fiscal year (FY) 1994 through FY 2001.

(2) Army activities and facilities in CONUS only.

(3) Toxic chemicals described in section 313(c) of the Emergency Planning and Community Right-to-Know Act (EPCRA).

(4) Pollution abatement and prevention opportunities and activities that are in research, development, demonstration, and commercialization.

(5) Selected case studies jointly identified with the study sponsor will be used to demonstrate the methodology.

THE BASIC APPROACH used in this study was first to identify pollution abatement and prevention opportunities by hazardous waste stream, and then define the pollution baseline at the US Army Materiel Command (AMC) base case sites. A multiobjective mathematical programming model was developed that generates pollution abatement and prevention investment strategies for Army facilities. The PAPA methodology was demonstrated in support of the Army's response to key

provisions of Executive Order 12856, Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements.

THE PRINCIPAL FINDINGS of the PAPA Study are:

(1) The PAPA methodology provides the Army's leadership with a quick turnaround capability for analyzing and integrating US environmental policy with the Army's environmental goals and its programming and budgeting process in support of the requirements of Executive Order 12856.

(2) The Army's environmental program can be more analytically based, integrated, and defensible by using the PAPA methodology.

(3) The utility of the RCS 1383 Environmental, Pollution Prevention, Control, and Abatement Report can be enhanced by the addition of project-specific life cycle costs, benefits, and waste stream/chemical identification data.

(4) The PAPA methodology is inherently flexible and capable of incorporating changes in policy, budgetary, and technical data elements to develop and evaluate alternative investment strategies within and across the pillars of the Army's environmental program.

(5) The PAPA methodology can be used by senior Army management to assess broad impacts of environmental policy changes and to assist in formulating new policy focused on achieving the Army's environmental objectives.

(6) Major Army command (MACOM) and installation commanders can use the data generated by PAPA methodology to better develop their installation-level investment strategies and corrective action compliance plans.

(7) Unexpected or unanticipated costs (e.g., notices of violation, Federal Facility Compliance Act enforcement, etc.) which occur during the execution year are considered "operating costs" and must be paid for out of the command's annual operating budget.

THE STUDY EFFORT was directed by LTC Michael J. Leibel, Resource Analysis Division, Resources and Sustainability Analysis, US Army Concepts Analysis Agency (CAA).

COMMENTS AND QUESTIONS may be sent to the Director, US Army Concepts Analysis Agency, ATTN: CSCA-RSR, 8120 Woodmont Avenue, Bethesda, Maryland 20814-2797.

CAA	**RESERVE COMPONENT TRAINING INSTALLATION FACILITY YEARLY REQUIREMENTS STUDY (RCTIFYRS)**	**STUDY SUMMARY CAA-SR-94-4**

THE REASON FOR PERFORMING THE STUDY was to develop and demonstrate a methodology and means for identifying and selecting training locations for the Army National Guard and Army Reserve based on economic, environmental, and readiness issues.

THE STUDY SPONSOR was the Assistant Deputy Chief of Staff for Operations and Plans (DAMO-ZB), Headquarters, Department of the Army.

THE STUDY OBJECTIVES were to:

(1) Identify and catalog all of the training facilities considered by the study. This activity is to include the verification of current capabilities and any changes in the training facilities' availability due to probable future events (e.g., Base Closure and Realignment Commission actions, force structure changes, etc.).

(2) Provide an assessment of Reserve Component (RC) training requirements versus facility capabilities to determine the efficient allocation of resources.

(3) Identify any economic, environmental, or readiness constraints which affect the availability or desirability of the facilities identified in the study.

(4) Develop capabilities to display the results in a fashion that would be useful and understandable to multiservice, Congressional, and executive bodies.

THE SCOPE OF THE STUDY included all federally and state owned installations suitable for use as major training areas and all fiscal year (FY) 95 RC units located in the continental United States. Reserve Component units were to be evaluated with respect to both their 14-day annual training (AT) period and their inactive duty training (IDT) requirements.

THE MAIN ASSUMPTIONS of this study are:

(1) Land requirements, by type of unit and mission, for annual training will be in accordance with Training Circular (TC) 25-1, Training Land.

(2) Annual training will not be restricted to the May through August timeframe traditionally favored by the Reserve Component.

(3) Nonroutine training opportunities (i.e., National Training Center and Joint Readiness Training Center rotations and overseas exercises) will not be considered.

(4) The existence of mobilization stations, regional training sites (RTS) equipment concentration sites (ECS), or other facilities improvements will not, initially, be included in the decision criteria.

(5) Political considerations (i.e., any factors not directly related to unit readiness) will not be included in the decision criteria.

(6) Unit locations and branch designations will be taken from the Structure and Manpower Allocation System (SAMAS). Modifications to unit standard requirement codes (SRCs) and locations will not be considered.

(7) All distances (from unit locations to training areas) will be measured from the centers of their respective zip codes using a flat earth, straightline calculation.

THE BASIC APPROACH called for identifying the training needs of the RC units and then cataloging the training resources available at each of the installations evaluated. Units were then allocated to the closest facility which met their training needs. The allocation was done using a first fit-largest bin packing procedure.

THE PRINCIPAL FINDINGS of the study are:

(1) The RCTIFYRS methodology provides a better tool for justifying the retention of training installations than it does for identifying facilities for closure. RCTIFYRS can be used to spotlight individual training sites and assess them in terms of the units they can support for AT and IDT, the alternative training facilities that these units would be forced to use should the site be closed, and the impact. RCTIFYRS does not consider mitigating factors (e.g., training resources unique to a given facility) which may argue against a site's closure, nor does it attempt to evaluate the "quality" of the training at one site as opposed to another.

(2) RCTIFYRS is only as accurate and current as the data that it uses. A comparison of Appendix D and Appendix E will highlight the differences between the data that was used in the study and the "ground truth" developed by surveying each of the 85 AT facilities. Similarly, using the November 1993 (instead of the 1992) version of the SAMAS increases the number of RC units under consideration from 2,550 to 2,751.

(3) An analysis of AT needs showed that sufficient capacity exists to meet all of the training needs of the FY 95 RC force over a 14-week period. However, this constitutes the minimum possible time horizon and results in a large number of units traveling excessive distances to reach their designated AT sites. The "quality" of the solution (i.e., the number of units able to travel less than a day to reach their training site) increases as the number of 2-week AT time periods under consideration increases. Ten 2-week AT time periods was used as the base line for the AT evaluation portion of this study.

(4) An analysis of IDT needs showed that RC units have reasonable (i.e., within half of a day's travel) access to all facilities/ranges that they may require, except tank/Bradley Table VIII and demolition ranges.

(5) An analysis of active duty training requirements, based upon the standards contained in TC 25-1, indicated that Ft Bragg, Ft Carson, Ft Hood, and Ft Riley (among others) should be fully committed to tenant unit training requirements and should therefore be unable to support the reserves.

(6) The construction of multiple launch rocket system (MLRS) firing ranges (or the upgrade of existing artillery ranges) at Camp Grayling and Ft Bragg would result in significant travel savings for two of the RC's four MLRS battalions.

THE STUDY EFFORT was directed by LTC Rodger A. Pudwill, Value Added Analysis Division, US Army Concepts Analysis Agency (CAA).

COMMENTS AND QUESTIONS may be sent to the Director, US Army Concepts Analysis Agency, ATTN: CSCA-RSV, 8120 Woodmont Avenue, Bethesda, Maryland 20814-2797.

Strategic Risk Analysis

STUDY GIST

The principal findings of the study were the identification of the impact of reduced active component (AC) end strengths on the Army's ability to support a CINC in a theater of operations and the Army's ability to react with military force to a potential conflict. The findings determined a breakpoint where AC end strengths below the breakpoint lacked sufficient personnel to fight two nearly simultaneous major regional contingencies (MRCs). Another breakpoint was identified where the time between MRCs was too short to allow lift assets to move Army units to both MRCs in a timely manner.

The main assumptions :

- One heavy brigade of equipment is pre-positioned on ships and enough CS/CSS equipment and resupply to support a corps for 30 days is pre-positioned on other ships.
- The President orders 200K reserve call-up at initiation of the first MRC.
- Reserve component combat brigades are available in 90 days after call-up.
- Strategically Fixed Forces, such as the 2nd ID, are not available out of theater.
- FY99 modernization of US forces is completed.

The principal limitations: There are three limitations that reduced the complexity of the problem. Forces allocated to LRCs and Strategically Fixed Forces are represented by subtracting their sum from the total end strength. Echelon Above Division forces were allocated to the two MRCs as a fixed proportion in relation to the number of divisions allocated to an MRC. The schedule of unit deployments within a force package remains the same under all conditions, but the arrival of the force package may shift in time due to a lack of lift assets or deployable troops.

The scope of the study was to examine a range of AC endstrengths with modernization of weapon systems and lift assets in the 1999 time frame. The time between MRCs varied from 0 to 100 days.

The study objectives: to determine what end strength will adequately meet the operational requirements of National Military Strategy, and what is the strategic risk associated with the end strength?

The basic approach measures strategic risk in terms of vulnerabilities to the Army's ability to meet its global responsibilities in support of potential conflicts and at the theater level in support of an ongoing conflict. The methodology consists of three primary parts: a deployment analysis, combat analysis, and development of a resource allocation spreadsheet to compute the measures of effectiveness. The main role of the deployment analysis was to determine the lift requirements for each MRC, how long it will take to deploy forces to each MRC if it is the first to occur, and when the lift assets will be available for the second MRC. This enabled the team to compute a

delay in force arrival for the second MRC based on its start time and the availability of troops and lift. A theater level combat model, TACWAR, was used to produce the combat results for each MRC. Runs of the combat model were made with varying delays for each MRC. A relationship between the delay times and the combat results from the model was developed. This relationship was used by the analysis tool, a spreadsheet, to compute the measures of strategic risk over a range of values for AC end strength, as well as, a range of values for the time between the start of the two MRCs. Strategic risk was measured in terms of the vulnerabilities the Army would face in meeting its global responsibilities to respond to any potential conflict and its theater responsibilities to support a CINC in fighting a current conflict. The spreadsheet displays these measures of strategic risk.

The reason for performing the study was to support the Army's position in the ongoing debate over the appropriate AC end strength required to execute the National Military Strategy. The study examined the risk associated with various AC end strengths in meeting the requirements to fight and win two nearly simultaneous MRCs. Given the current debate over the final end strength of the Army, it is important for the senior leadership to understand the strategic risk associated with this end strength under varying conditions.

The study impact: This study was briefed to Commander, TRADOC, the Vice Chief of Staff of the Army, and the Secretary of the Army. The study provided an analytical basis for decisions regarding strategic risk and the end strength of the active component of the Army.

The study sponsor was the CG, TRADOC.

The study proponent was the CG, TRADOC.

The performing organization and principal authors: The study was performed by the Study Directorate of the TRAC Study and Analysis Center, TRADOC Analysis Center. Principal authors are COL Thomas J. Pawlowski, III, Mr. Roland Groover, and Mr. Steven Schorr.

Comments and questions may be sent to :

USA TRADOC ANALYSIS CENTER
Fort Leavenworth, KS, 66027

POC: Mr. Roland Groover DSN: 552-9220, (913)-684-9220

The start and completion dates: The study was started in early September 1993 and was finished in early December 1993.

Study Gist

THE RECONSTITUTION STUDY

THE REASON FOR PERFORMING THE STUDY: The reason for performing the study was to assess the required time to perform tasks associated with reconstituting and redeploying a combat force from one Major Regional Contingency (MRC), South West Asia (SWA), to another, North East Asia (NEA). The study originated from a personal request from the Training and Doctrine Command (TRADOC) Commander.

THE PRINCIPAL RESULTS: The principal results of the study were: (a) using doctrinally accepted procedures, there is a ninety percent likelihood that it will take forty-five to sixty-two days to regenerate and redeploy a Combat Heavy Division from SWA to NEA; (b) it will take at least thirty-one to forty days to redeploy this Division "as is" without regenerating it to full strength; (c) SWA will have significant shortages in Combat Support/Combat Service Support (CS/CSS) units; (d) about twenty-eight percent of the CS/CSS units and eighteen percent of the soldiers for NEA will have to be redeployed from SWA; and (e) even with SWA redeployment of CS/CSS units, NEA will be short about twenty-seven percent of its required units and about twelve percent of its required soldiers.

THE MAIN ASSUMPTIONS: The main assumptions used in the analysis were: (a) the President orders 200,000 reserve call-up at the initiation of the SWA MRC; (b) hostilities in SWA have ceased prior to the order to redeploy the Heavy Division; (c) the Mobility Requirements Study recommendations have been implemented (thus making available the required sea and air lift assets and prepositioned equipment); (d) there is adequate sea and air lift to redeploy the force from SWA to NEA; (e) prepositioned afloat equipment will be committed to SWA; (f) priority of SWA support will be given to those units redeploying to NEA; (g) both SWA and NEA port facilities have not been degraded and available materiel handling equipment in both regions will be adequate; and (h) host nation support will be available and extensively used in both regions.

THE MAJOR RESTRICTIONS: This study was limited to determining and evaluating the macro level times and tasks necessary to regenerate and redeploy a Heavy Division from SWA to NEA. This study did not evaluate the total lift requirements to deploy the force (either SWA or NEA). The Total Army Analysis (TAA) SWA and NEA force structures for the year 1999 were used. The redeploying Heavy Division has been reduced by fifteen percent in personnel and equipment.

THE SCOPE OF THE STUDY: The study focused on the tasks and time required to bring a Heavy Division from its SWA cease fire location to the Tactical Assembly Area (TAA) to a reconstitution site; to regenerate the unit to one hundred percent equipment, personnel, and supplies; to move both soldiers and equipment to the port; to transport equipment and soldiers to a second MRC; and to unite the soldiers with their equipment at the TAA in the second MRC A second part of the study evaluated the requirements and availability of critical CS and CSS units required by both MRCs.

THE STUDY OBJECTIVES: The objectives of the study were: (a) to determine what is required to move, prepare, and certify a Heavy Division as combat ready for a second MRC and (b) to evaluate critical CS and CSS units needed to support two nearly simultaneous MRCs.

THE BASIC APPROACH: The basic approach used by the study team was to develop a structured data gathering process, to solicit task and time data from doctrinal subject matter experts, and then to develop a computer model using the data thus generated to evaluate timelines and critical tasks. The study also matched the TAA 2001 force structure against the Structure and Manpower Allocation System (SAMAS) file to produce lists of CS/CSS units found short for either/both SWA and NEA.

THE STUDY SPONSOR: The TRADOC Commander was the study sponsor.

THE STUDY PROPONENT: The TRADOC Commander was the study proponent.

THE STUDY AGENCY: TRADOC Analysis Center (TRAC) - Fort Lee.

TRAINING READINESS IN THE ARMY RESERVE COMPONENTS

REASONS FOR PERFORMING THIS STUDY

By most if not all measures, the Persian Gulf war was a very demanding and successful military deployment, including the first call-up of Reserve Component units in more than 20 years. Generally speaking, the system performed well. But the demands of future conflicts may pose more difficult challenges, and the United States may be less well situated to meet them.

In light of future requirements and the Gulf war experience, the Army and other agencies undertook a number of efforts to examine the need for readiness improvements in the Army's Reserve Components (RC). During 1992, these efforts culminated in an extensive pilot program called "Bold Shift." This program involved collaborative efforts by the Active Army, the National Guard, and the U.S. Army Reserve to enhance the readiness of selected high-priority units that may be needed quickly in future crises.

THE STUDY OBJECTIVES

This study analyzed the activities and performance of units that participated in Bold Shift during 1992, with the intent of understanding the units' training achievements and shortfalls, identifying key factors underlying training readiness, and suggesting potential improvements.

STUDY SCOPE

1. The study examined the collective training activities at annual training and monthly drill training, personnel readiness and skill qualification, and leader training for Bold Shift units during 1992.

THE BASIC APPROACH

The researchers collected information on Bold Shift program activities, on resources expended, on assessments of Mission Essential Task List (METL) tasks trained, and on participants' perceptions of program strengths and weaknesses. RAND staff visited and observed selected Bold Shift units (including six brigades and several nondivisional support units); refined existing assessment procedures (e.g., the Training Assessment Model, TAM, and the Operational Readiness Exercise, ORE); collected new data on performance of gunnery, maneuver, and other collective tasks; and conducted standardized surveys and interviews with unit members, commanders, and members of the RC and AC chain of command.

THE PRINCIPAL FINDINGS

1. The initial implementation of Bold Shift was very successful in many dimensions. The main features of the program—training to more realistically attainable pre-mobilization goals, new concepts for field training, and closer ties between the AC and RC—seemed to be moving in the right direction and well worth continuing. A large majority of unit members and leaders regarded Bold Shift as effective in improving the readiness of their unit for its wartime mission. The vast majority felt that the program should be continued, and believed that the program should be expanded to other RC units.

2. While successful in concept and features, the program was not able to bring most pilot units to their pre-mobilization training and readiness goals. Results suggest that the pre-mobilization goals for combat support (CS) and combat service support (CSS) units may be attainable if continued improvements can be made. For combat units, the results appear

less optimistic. For example, in tank battalions only about 30 percent of authorized crews successfully completed Table VIII gunnery exercises, and in mechanized infantry units most platoons had time to practice only a subset of essential maneuver tasks.

3. In all cases personnel readiness—having sufficient trained and deployable personnel—is a challenge. High personnel attrition and turbulence in RC units lead to low MOS qualification, take soldiers away from their units, and impede collective training. In these units, about 25 percent of the members were not MOS qualified and 30 percent did not attend AT with their unit.

4. Overall, future programs need to bear in mind two features of reserve experience: the need for *stability* in personnel and *efficiency* in use of soldiers' time. Given the basic features of reserve service—modest amounts of training time, split into infrequent training periods—there is every opportunity for skills to atrophy and changes in personnel to disrupt relationships that are essential to collective proficiency and unit cohesion. To overcome these challenges, the reserve forces need a more stable and efficient environment to allow individual skills to mature and groups of individuals to grow into capable fighting forces.

THE MAIN ASSUMPTIONS

1. The training readiness demands that existed in 1992 will remain relatively unchanged.

2. The set of units examined represented the highest priority units in the RC during 1992.

THE PRINCIPAL LIMITATIONS

1. The study was limited to a snapshot of conditions and activities for only a small set of units during the very first year of implementation of the Bold Shift initiatives.

STUDY IMPACT

The study established the levels of peacetime readiness achieved by high-priority brigades under the Army's new RC training program (Bold Shift) and provided the basis for Forces Command and the Department of the Army plans for post-mobilization training of RC combat brigades before deployment to a wartime theater.

STUDY SPONSOR

This study was sponsored by the Commanding General, U.S. Army Forces Command.

PERFORMING ORGANIZATION AND PRINCIPAL AUTHORS

The Arroyo Center
RAND
1700 Main Street
P.O. Box 2138
Santa Monica, CA 90407-2138
(310) 393-0411

Principal authors are Ronald Sortor and Thomas Lippiatt.

DTIC ACCESSION NUMBER ON FINAL REPORT

Presently not available.

COMMENTS AND QUESTIONS MAY BE SENT TO

Ronald Sortor
The Arroyo Center
RAND
1700 Main Street
P.O. Box 2138
Santa Monica, CA 90407-2138
(310) 393-0411 x-7129

START AND COMPLETION DATE OF THE STUDY

February 1992–June 1994

Use of Physics of Failure for Reliability Evaluations in Support of Commercial Technology Insertion

Principal findings

The commercial version of the Joint Surveillance Target Attack Radar System (JSTARS) Light Ground Station Module (LGSM) processor Circuit Card Assembly (CCA) can be used instead of the ruggedized version. The commercial CCA costs $7,000 and the ruggedized CCA costs $19,000. By using the commercial CCA, the total cost savings just for Limited Rate Initial Production (LRIP) are over $1,200,000. Also, with future procurements and with the ability to leverage the commercial market for product improvements, the overall cost savings are expected to be significantly more. The study used failure mechanism modeling along with thermal and vibrational analysis to determine that solder joint fatigue would not cause the commercial board to fail within eleven years. A next generation processor would be expected to be in place before that time. This approach provided a comprehensive and science-based way to evaluate the capability of a commercial product to survive in the Army environment. The Program Manager will now be using the commercial CCA as a result of this study. The results were consistent with peer reviewed and published failure mechanism models. This approach can be extended to other Army systems and commercial products to achieve significant cost savings and to leverage the commercial technical base.

Main assumptions

(a) The Joint STARS specification vibration profile reflects or exceeds the actual operating environment.

(b) Steinberg's approach to fatigue accurately reflects the solder joint life of the CCA.

(c) Stresses acting in the plane of the CCA dominate the CCA vibrational behavior.

(d) CCA deflections are small compared to the CCA thickness.

Principle limitations

The analysis is unique to the JSTARS processor CCA in the specified Army environment. Other boards and other environments would require a separate analysis.

Scope of the study

To determine if the commercial Joint STARS LGSM processor CCA can be used instead of the more expensive ruggedized version to achieve significant cost savings and to leverage off of the commercial technical base.

Study Objectives

To evaluate whether the thermal and vibrational stresses imposed on the CCA in the Army environment would exceed the strength of the commercial version of the CCA.

Basic approach

Apply a physics-of-failure approach to examine the impact of the Army environment on the circuit card solder joints for both the commercial and ruggedized versions. Steinberg's approach was used to project CCA life. Finite element and finite difference analyses were used to determine vibrational and thermal profiles. The analysis accounted for differences in the circuit card materials, geometries, architectures and stress loading.

Reasons for performing the study

To provide information to the JSTARS Program Manager which would help him determine if he should use the commercial version of the CCA.

Study Impact

As a result of the study, the Program Manager will be using the commercial board. The anticipated cost savings just for LRIP are expected to exceed $1,200,000. Future savings based upon future procurements and the ability to leverage off of the commercial market are expected to be significantly more.

Study sponsor

Program Manager JSTARS

Performing organization and principal authors

U.S. Army Materiel Systems Analysis Activity

Thomas J. Stadterman
Barry T. Hum
Michael W. Deckert
David E. Mortin

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TBD - Paper accepted for publication by the International Society of Science and Applied Technologies. Currently working to reformat and submit to DTIC.

Comments and questions may be sent to

Director USAMSAA
ATTN: AMXSY-RE (Mortin)
Aberdeen Proving Ground, MD 21005-5071

POC is David E. Mortin (410) 278-6792 DSN: 298-6792

Start and completion dates of the study

April 1994 - September 1994

ABSTRACTS OF THE DR. WILBUR B. PAYNE MEMORIAL

AWARD FOR EXCELLENCE IN ANALYSIS 1994 PAPERS

CITATION

Individual Category

Dr. Wilbur B. Payne Memorial Award for Excellence in Analysis

1994

Recent criticisms that minority personnel have been disproportionately represented in the Army's justice system prompted the Deputy Chief of Staff for Personnel to task the US Army Concepts Analysis Agency to evaluate the court-martial process. The result is the *Equitability of Treatment in Army Judicial Proceedings* report by Mr. James J. Connelly, CAA analyst. Mr. Connelly worked with Army wide court-martial proceedings for 1987 to 1992, using Clerk of the Courts case data, and focussed his analysis on cases involving African-American and Caucasian enlisted soldiers. He characterized the court-martial process and the offenders by data elements drawn from the case files and applied cross-tabulation, discriminant analysis, and tree-structured classification methods to those data. Mr. Connelly found that differences in treatment were small in magnitude and not consistently associated with a single race. The study results suggest that the trial process, as characterized by the factors, is not sensitive to race. The overall analysis indicated no evidence of inequitable treatment of African-American offenders within the Army judicial system. Subsequent external review prompted the Deputy Chief of Staff for Personnel to conclude that the study is "an important finding, and a confirmation of the current policy, procedures and practices in military trial proceedings" and that the study "will serve as an important reference for understanding the minority experience with military justice." The analysis has provided the Army with a well-defined baseline for understanding issues surrounding minority experience within its justice system. In recognition of his outstanding achievement and analytical skills in conducting the *Equitability of Treatment in Army Judicial Proceedings* study, Mr. Connelly is presented with the 1994 Dr. Wilbur B. Payne Memorial Award for Excellence in Analysis, individual category.

CITATION
Group Category
Dr. Wilbur B. Payne Memorial Award for Excellence in Analysis
1994

Ms. Barbara Borchardt, Captain Fletcher H. Griffis, and Messrs. Richard W. Porter, Stanley N. Gray, and Richard R. Laferriere, US Army TRADOC Analysis Center - White Sands Missile Range are commended for their work on the *Early Entry Analysis: Division Ready Brigade*. Through their diligence and the application of innovative simulation and analytic skills, the team provided information on over 22 candidate systems for the TRADOC Early Entry Battle Laboratory. The analysis integrated combat effectiveness across three scenarios, airlift requirements, and force structure, and included the impact of the costs of the systems. About 50 CASTFOREM runs were economically combined into over 60 Mix Model runs to provide data to define the best synergistic mixes of systems that will enhance the lethality and survivability of the early entry force. The team members foresight, advanced used of computing tools, and the application of scenario analysis to this complex problem allowed the study to be completed in a short period of time, with varied applications of initial conditions and costs. The novel approach used by the group elevates resource requirements to the same level as force requirements; such focus will help broaden the scope of future effectiveness analyses. The result of the study is a set of effective early entry forces that are prepared to fight in the most likely contingencies throughout the world, and to follow through against additional threats. In recognition of their outstanding achievement in completing this valuable work, Ms. Borchardt, Captain Griffis, and Messrs. Porter, Gray, and Laferriere are commended and awarded the 1994 Dr. Wilbur B. Payne Memorial Award for Excellence in Analysis, group category.